PRESS KIT

ADEME-Arcep study: assessment of the digital environmental footprint in France in 2020, 2030 and 2050

March 2023

Because it enables the development of new ways to communicate (videoconferencing, etc.), easier optimisation and connection between stakeholders (optimised travel itineraries…), and greater knowledge of and ability to manage assets (battery, incorporation of renewable energy sources) digital technology is and will be a major contributor to the green transition.

But, as with any technology, digital technologies require resources to produce and use them, as well as network and storage infrastructures to support their operation.

In August 2020, the Ministry of the Ecological Transition and the Ministry of the Economy, Finance and the Recovery assigned ADEME and ARCEP the joint task of measuring the digital environmental footprint in France, and of identifying levers for action and best practices for reducing it.

In January 2022, the two organisations delivered the first two volumes of the study, assessing the impact of ICT as a whole in 2020, and in March 2023 delivered the third and final volume, providing a forward-looking assessment of the digital environmental footprint up to 2030 and 2050.

What are the study's main findings?

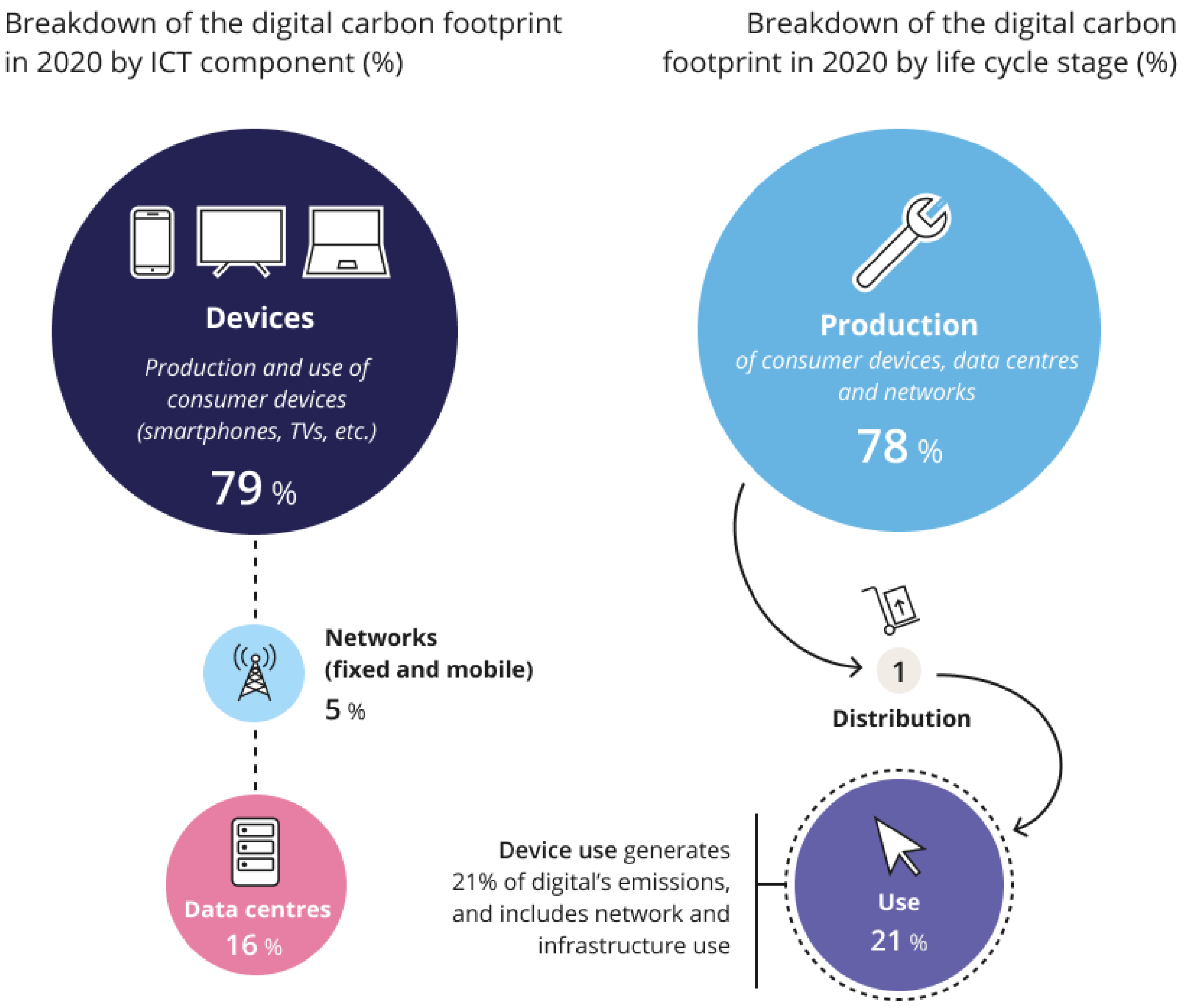
1 State of affairs in 2020: our devices and their lifespan, number one contributor to the digital environmental footprint

1.1 A study of the digital carbon footprint that highlights the impact of our digital devices

Digital technology is typically broken down into three categories (or tiers) when measuring its environmental footprint: end-user devices (TVs, smartphones, computers, etc.), data centres, and network infrastructures (fixed and mobile), which connect users to each other and to data centres.

Today, devices account for 79% of the digital carbon footprint, compared to around 16% for data centres and 5% for networks. And even though the amount of time we spend on our screens has increased substantially over the past several decades, it is not the use of this equipment (and so their electricity consumption) that is the main contributor to their carbon footprint… but rather their production, which accounts for 80% of their environmental impact!

Devices and their production account for the overwhelming majority of the digital carbon footprint



In other words, **before we have even used our brand new smartphone, television or computer, it has already produced close to 80% of the greenhouse gas emissions that it will generate during its (too short) life.** Although regularly conducted by air as an adjunct to maritime transport, the footprint created its distribution appears anecdotal in comparison (1%). Its utilisation accounts for the remaining share of emissions, or close to 20%.

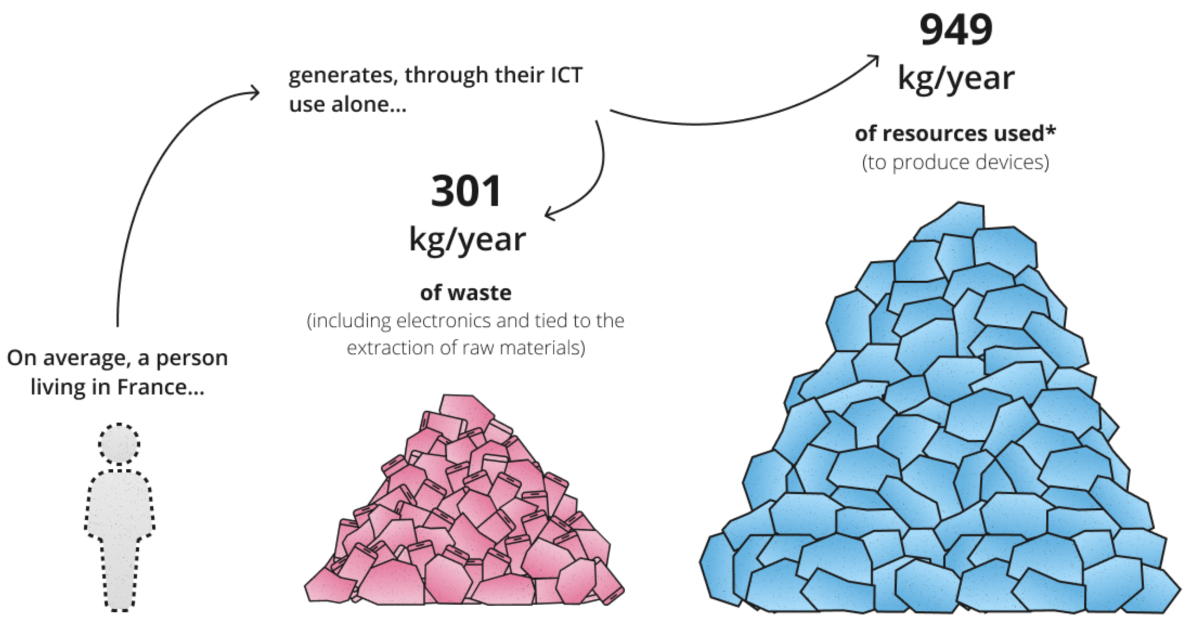
Whether we examine the digital carbon footprint by major tier or by life cycle stage, we conclude that the majority of emissions are generated by the production of user devices (smartphones, televisions and computers, for instance).

1.2 Resource, metal and mineral consumption: the digital environmental footprint is not confined to the carbon footprint

Device production's very substantial contribution to the sector's carbon footprint reminds us that digital services and the digitalisation they underpin in fact depend on very real and resource-consuming infrastructures and devices. Digital technology is also contributing to the depletion of certain metals and minerals, in the same way as other industries. To give an example, from their ICT use alone, a person living in France generates close to 300 kilos of waste per year (including electric and electronic waste as well as waste tied to the extraction of raw materials)

Close to a tonne of material used per person each year to feed our digital habits

The quantity of resources used and waste produced each year to support the ICT use of a person living in France in 2020



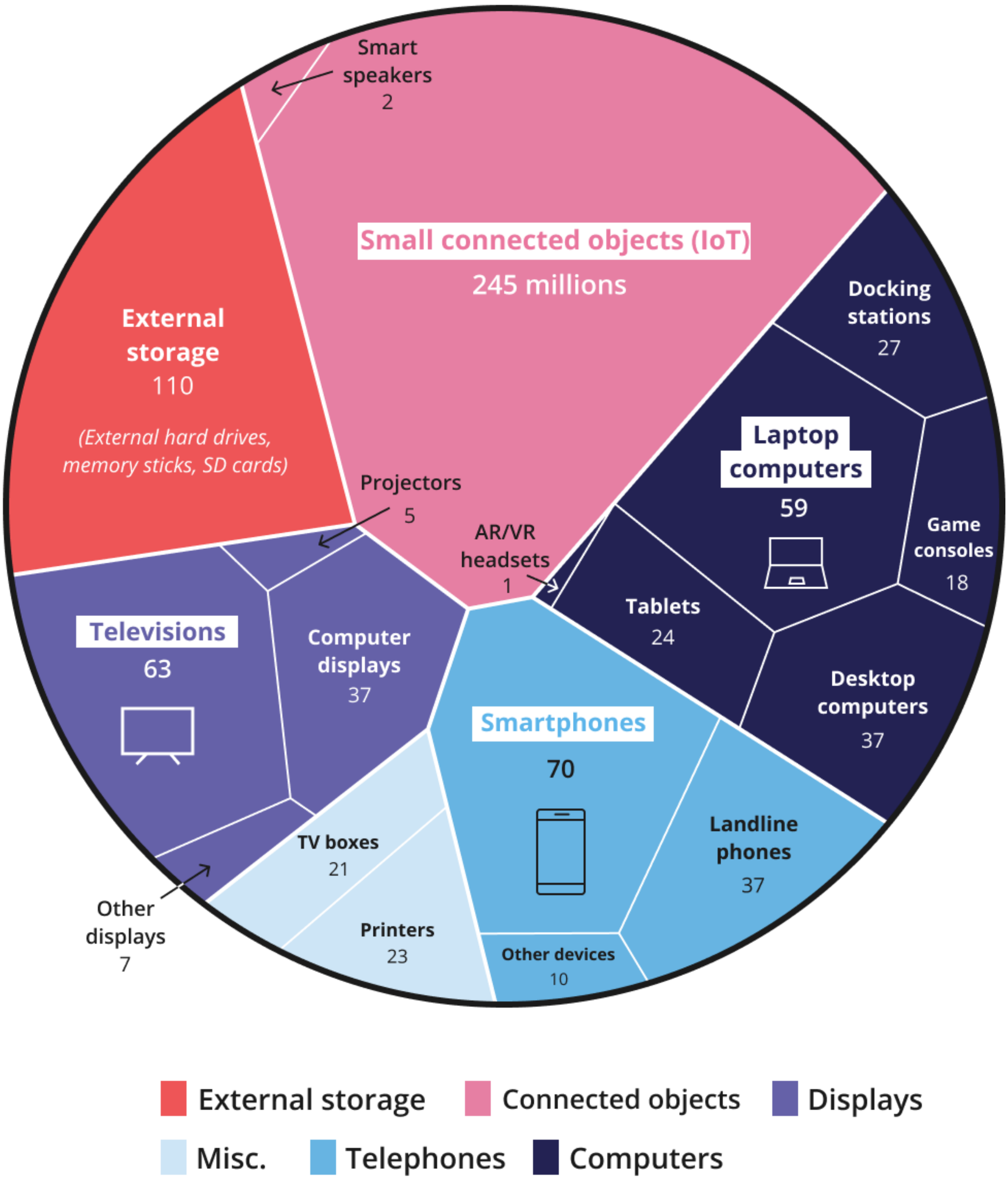
* including abiotic resources (materials, fossil fuels...), biomass, soil movement and water.

1.3 Significantly disparate impacts depending on the device

In 2020, the number of devices in circulation in France was estimated at close to 800 million. This includes a large number of connected objects, but the devices with the largest carbon footprint and which are the focus of our attention are by far smartphones, televisions and desktop and laptop computers. Together, they represent more than half of digital's greenhouse gas emissions.

More than 800 million* end-user devices in 2020 in France

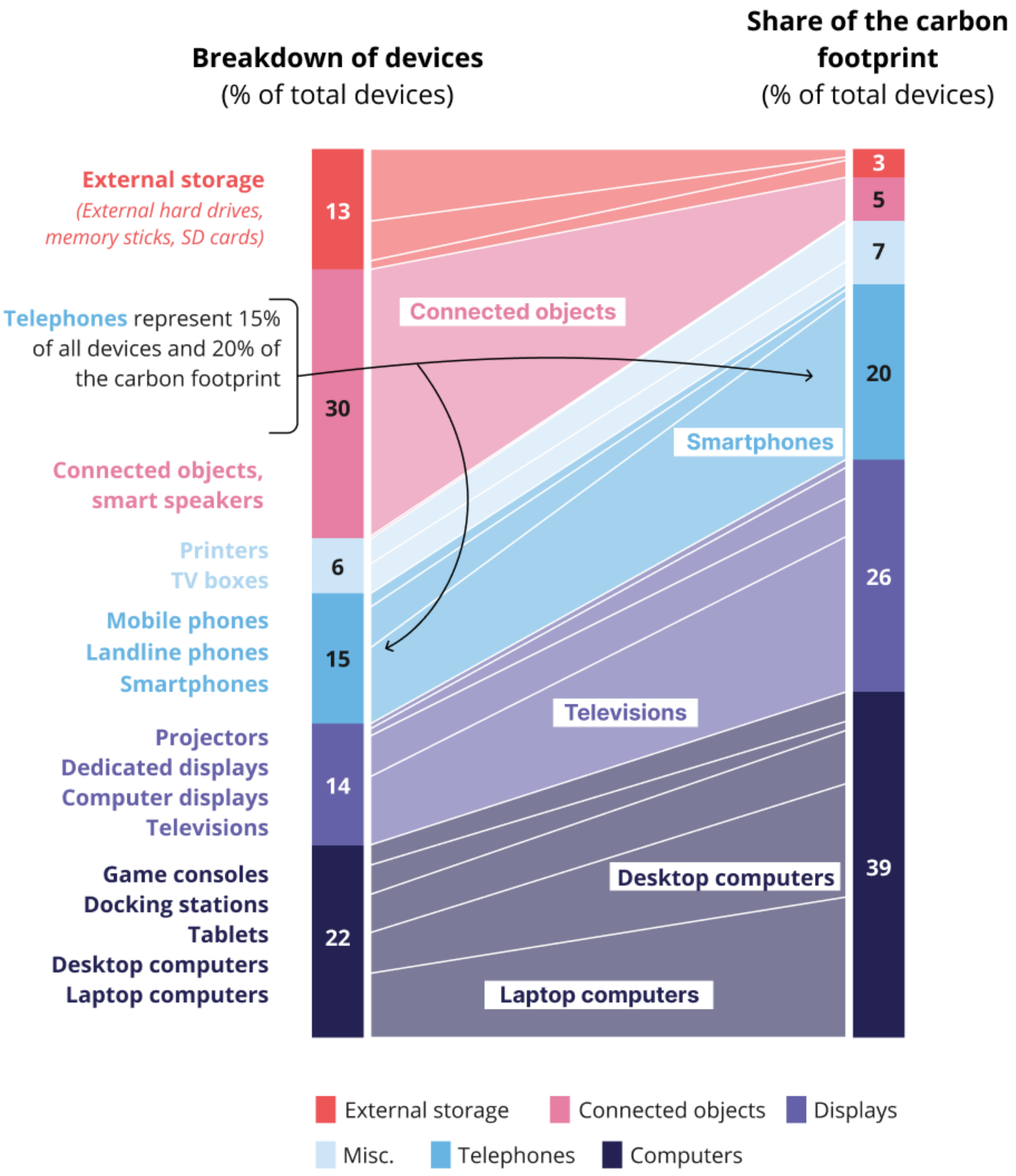
Estimated number of end-user devices in France, for personal and business use (million)



* These data are estimates derived from an inventory performed to model the digital environmental footprint for the purposes of this study. They are generally estimated based on information that was available at the time of working, and may come from different sources.

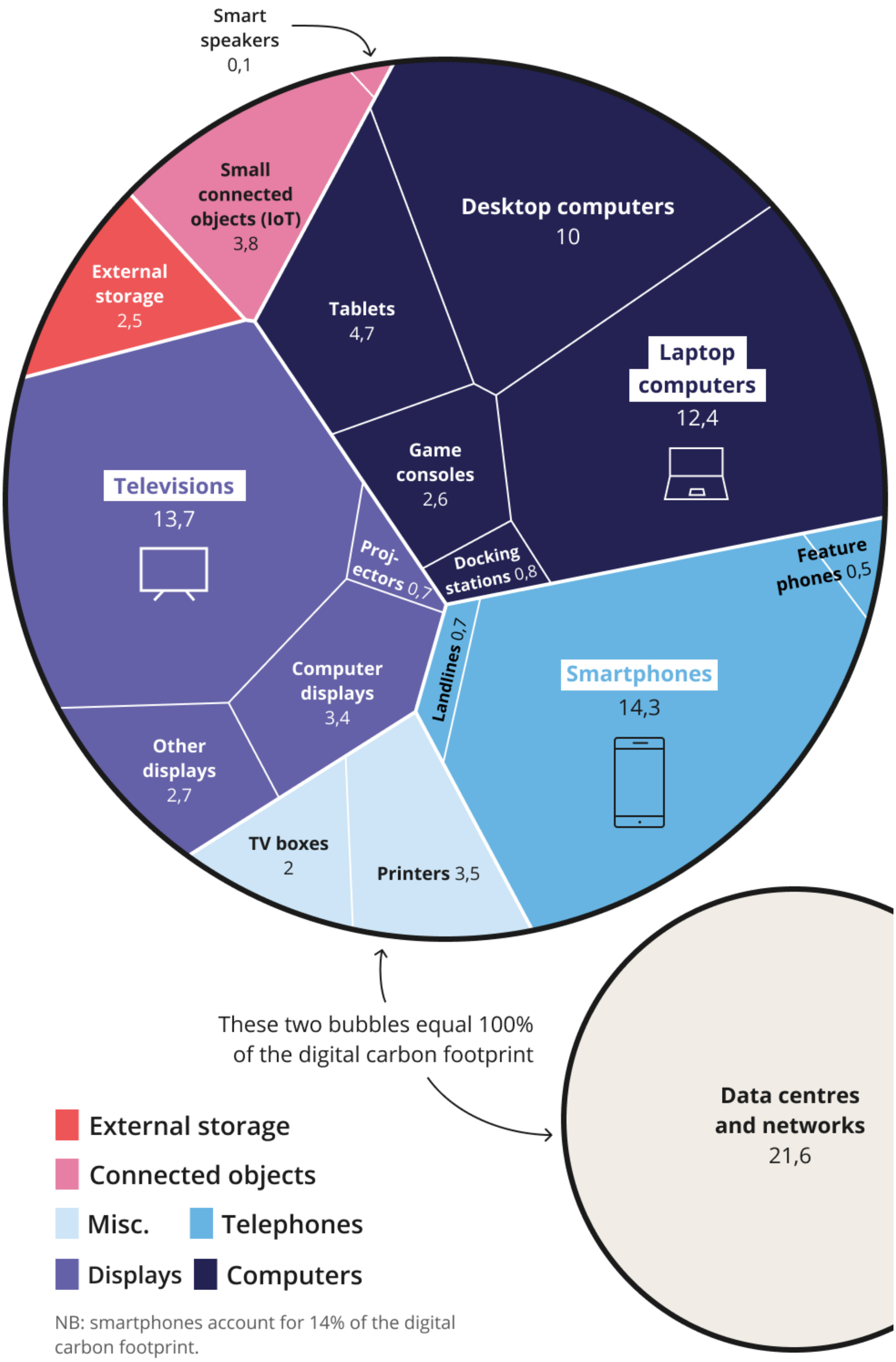
Devices' share of the digital carbon footprint, compared to their numbers

Breakdown of the number of devices in France and comparison with their share of the carbon footprint (for their entire lifecycle)



Smartphones and televisions: the two main sources of the digital carbon footprint

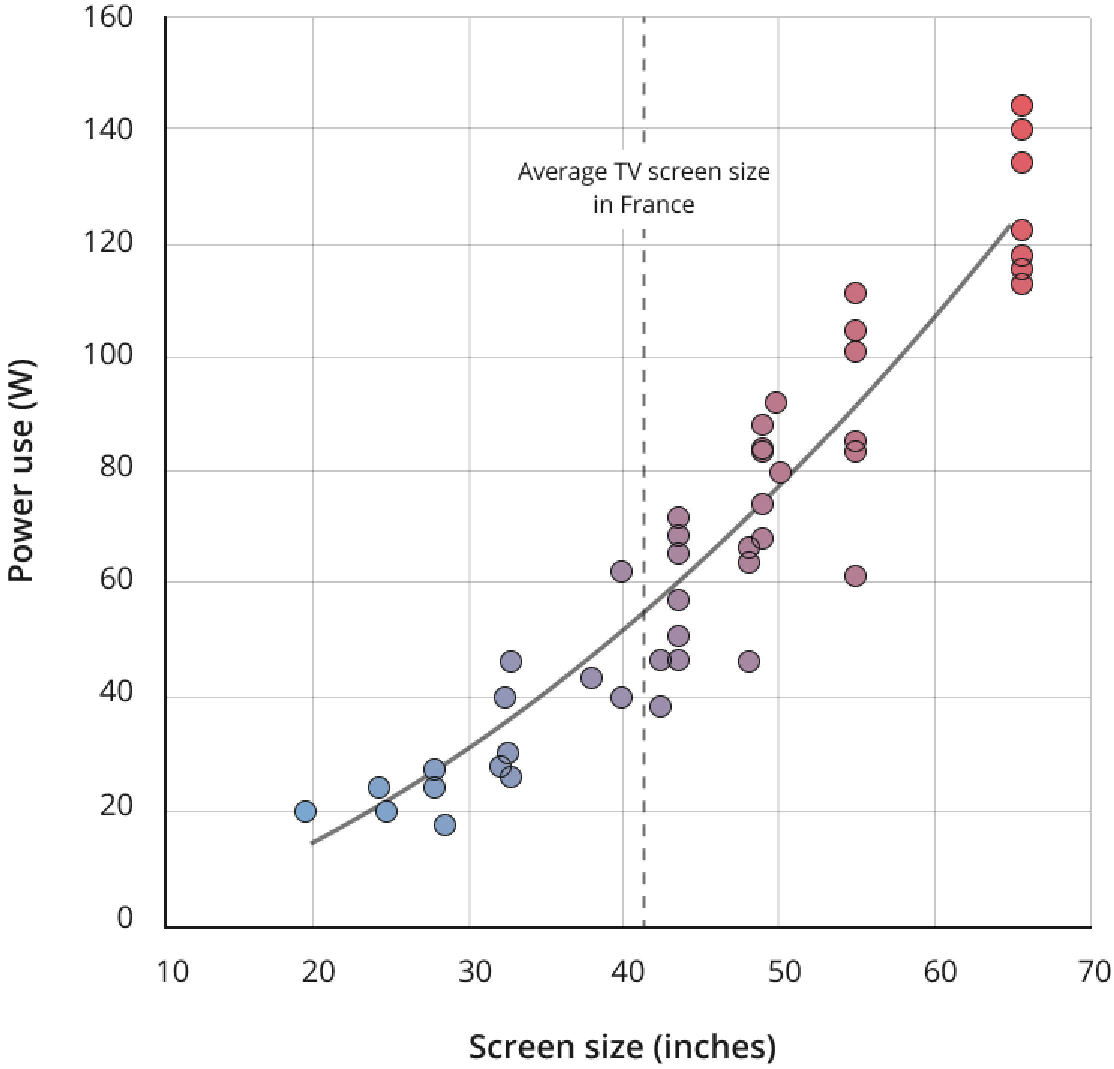
The digital carbon footprint of each type of device (across its life cycle) in 2020 is compared to data centres and networks' footprint (%)



NB: smartphones account for 14% of the digital carbon footprint.

The bigger the screen, the more power it consumes

The size and power use of a selection of 58 computer and TV displays



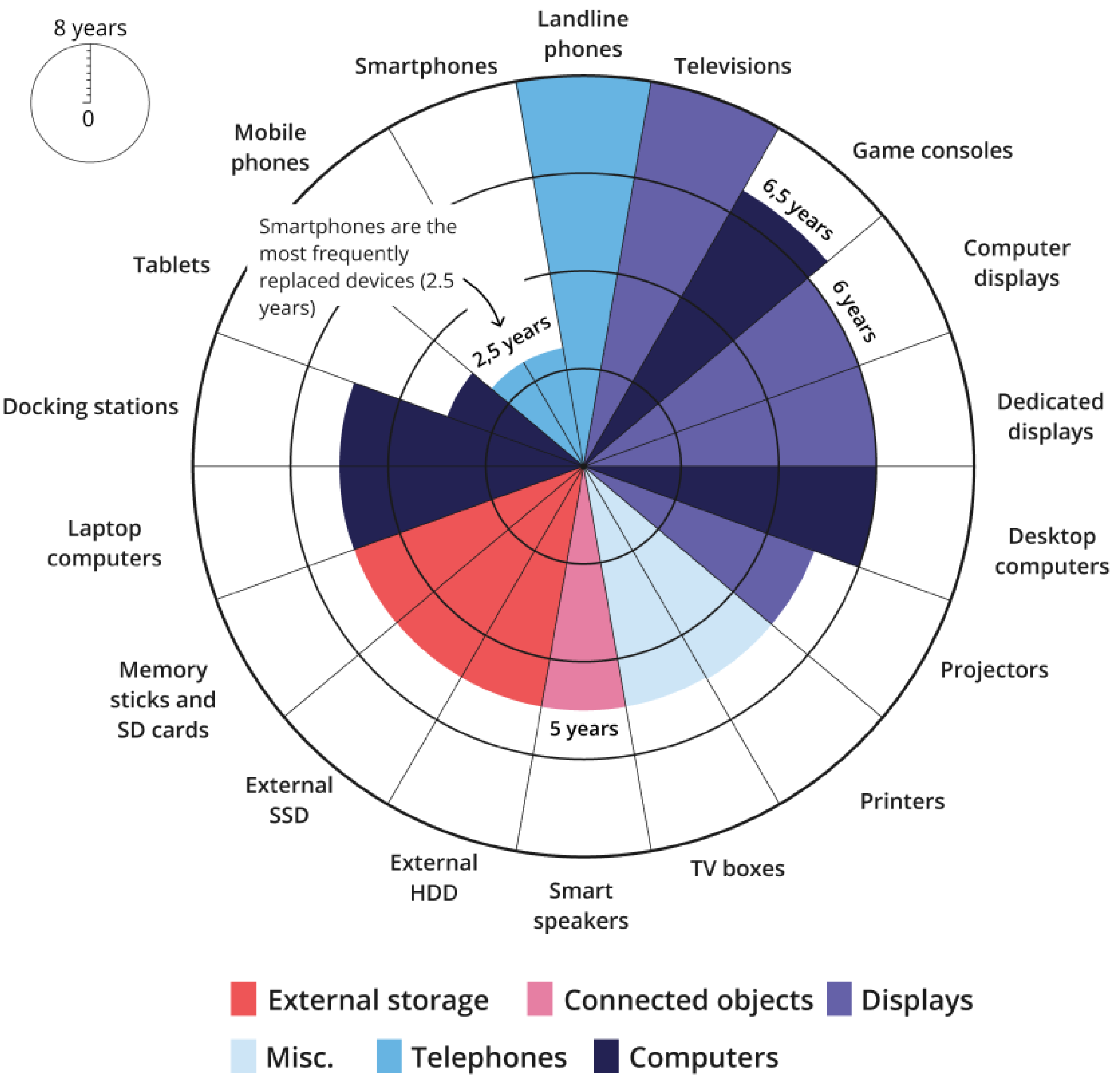
Source: Consumer goods and device life cycle analysis modelling and assessment produced by ADEME and presented in Part 2 (J. Lhotellier, E. Lees, E. Bossanne, S Pesne). March 2018

1.4 Devices' environmental impact determined in part by their short lifespan

The short life of devices heavily influences their environmental footprint. This is particularly true of smartphones, which are used for an average two and a half years, and tablets (around 3 years). These lifespans (established chiefly by compiling data from other studies) are nevertheless hard to measure precisely, and need to be the subject of additional data collection campaigns in future, to gain a more accurate understanding of the digital environmental footprint. Expanding devices' lifespan (which can go by way of using our devices for longer, by repairing them, refurbishing them for a new user, and better end-of-life recycling of their component parts) is an important lever for action for reducing the digital environmental footprint (See Part 3 of this press kit, devoted to the levers for action identified by the ADEME-Arcep study).

The more frequently a device is replaced, the greater its environmental impact

Estimated life* of the different devices



* These data are estimates derived from an inventory performed to model the digital environmental footprint for the purposes of this study. They are generally estimated based on information that was available at the time of working, and may come from different sources.

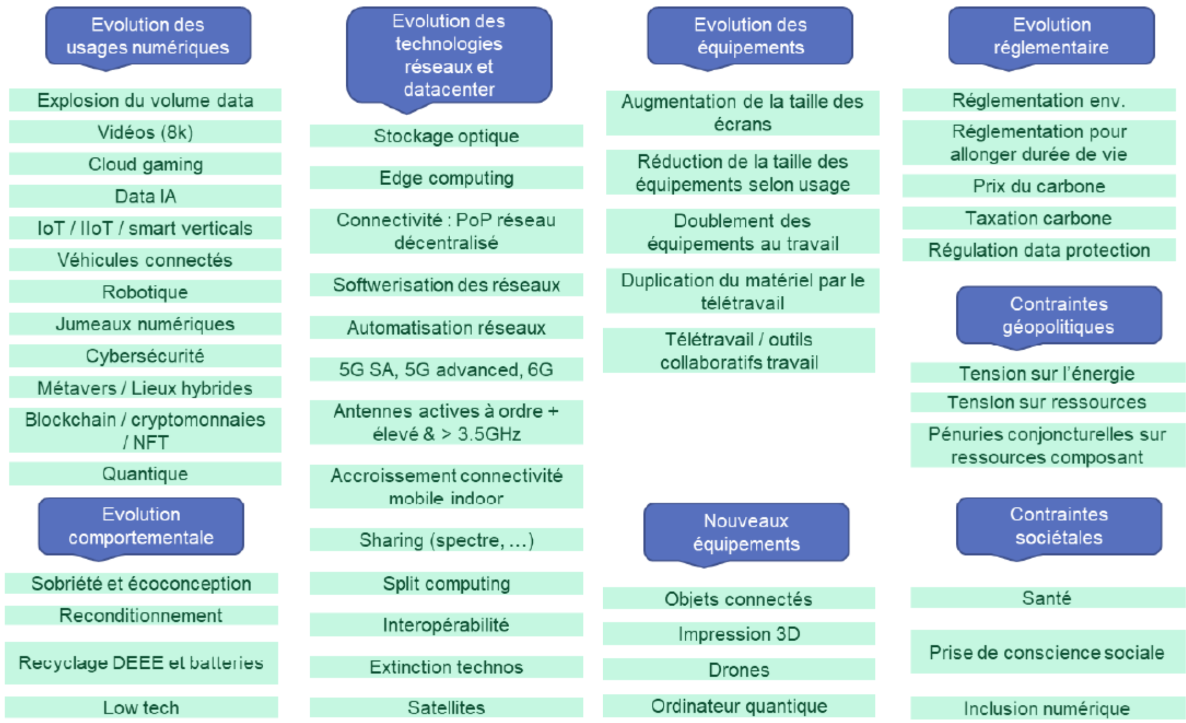
2 If no action is taken to curtail the growth of the digital environmental footprint, its carbon footprint could triple between 2020 and 2050

2.1 Hypotheses of the ADEME-Arcep study's forward-looking analyses

In their study, ADEME and Arcep establish a baseline scenario by projecting current digital trends into the future. The "business-as-usual" scenario, which applies up to 2030 and to 2050, is based on the hypothesis that existing trends – whether they correspond to a decrease (e.g. the ongoing decrease in devices' unit consumption of energy, or replacing the legacy copper network with a fibre network that consumes three times less energy[1]) or an increase (e.g. the deployment of new infrastructures to keep pace with growing usage) – in the environmental impact continue unabated.

ADEME-Arcep working group document listing

potential game-changers in the digital sector



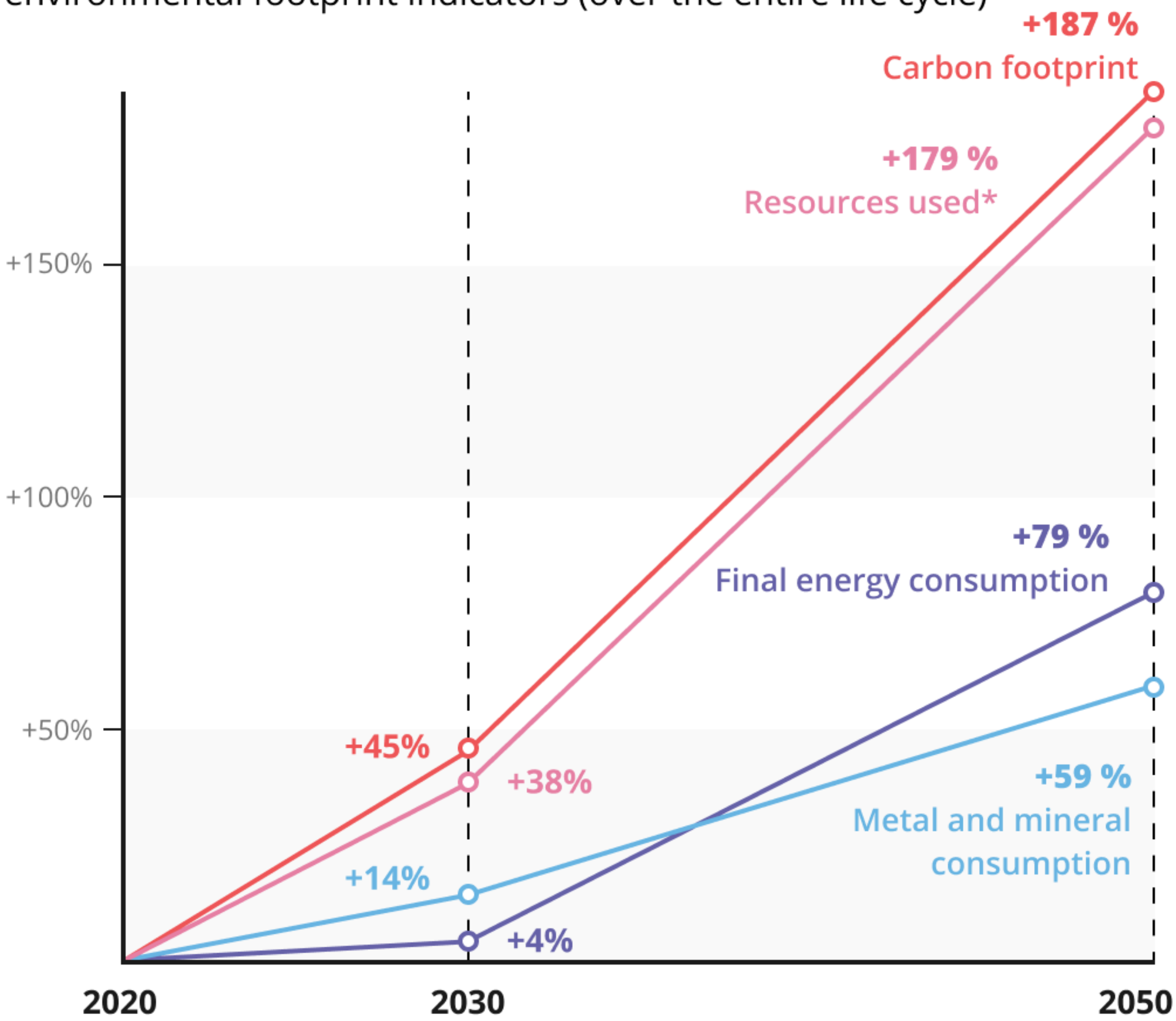
2.2 Under the business-as-usual scenario, digital's greenhouse gas emissions increase by 45% by 2030, and triple by 2050

According to this business-as-usual scenario, all of the environmental impacts would increase sharply between now and 2030 and 2050. The digital sector's greenhouse gas emissions in particular would grow threefold by 2050.

[1] IDATE DigiWorld 2021 commission, to be compared to the factor of four indicated by Arcep in its annual survey on Achieving digital sustainability, in April 2022.

If no steps are taken, digital's GHG emissions could increase by 45% by 2030, and triple by 2050

Progression of the business-as-usual scenario for the four digital environmental footprint indicators (over the entire life cycle)



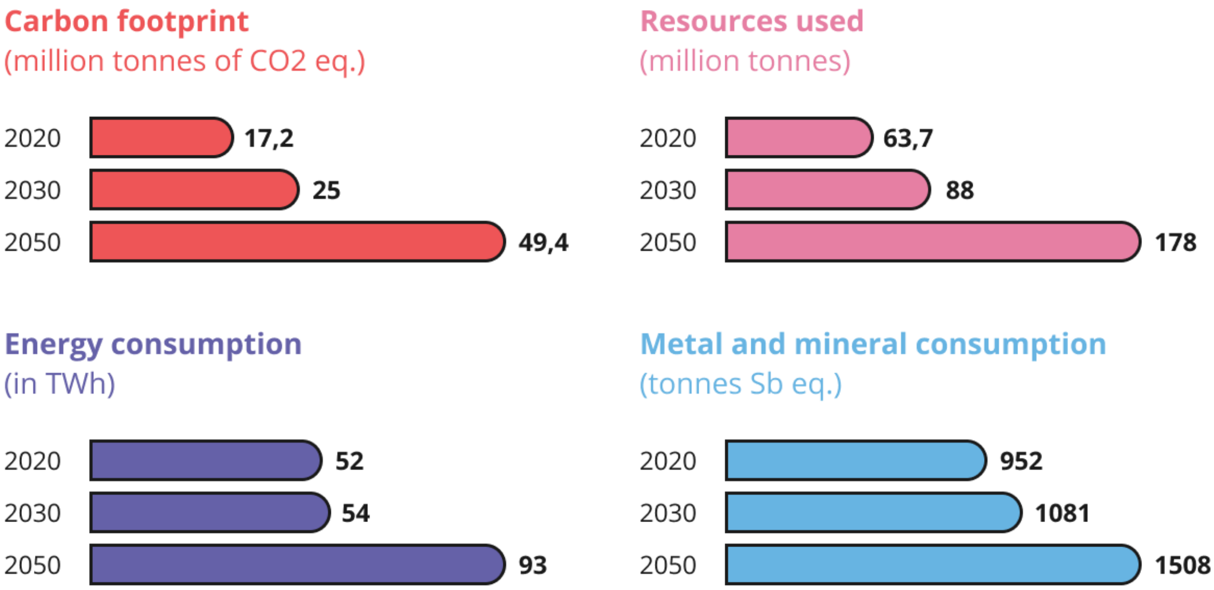
* MIPS definition factoring in materials used, biomass, soil movement, either mechanical or due to erosion, water and air.

This growing impact would be driven by rising consumption, itself spurred by the growing number of data centres, which could represent 22% of the digital sector's greenhouse gas emissions in 2050, despite the use of technologies that make them more energy efficient.

This distribution of impact must not, however, make us lose sight of digital's ecosystemic dimension: the interdependence between devices, networks and data centres created by consumption must be taken into account when drafting public policies targeting the digital environmental footprint as a whole.

Indicators established from a standardised life cycle assessment method that contains detailed definitions

Progression of the four digital environmental footprint indicators under the business-as-usual scenario, in absolute values



Carbon footprint: Greenhouse gas emissions expressed in CO_2 equivalent.

Resources used: MIPS indicators, which examine five types of resource, including abiotic (materials, fossil fuels...), biomass, soil movement, either mechanical or due to erosion, water and air. It gives an idea of the effort required to produce our goods and services.

Final energy consumption: refers to the energy consumed directly by end users, in the form of either electricity or petrol.

Metal and mineral consumption: this indicator assesses the quantity of metal and mineral resources extracted from the earth, expressed as antimony equivalent (a chemical element with the symbol Sb in the periodic table). This is a life cycle analysis standard for measuring the depletion of natural resources).

3 Levers for action identified to reduce the digital environmental footprint by 2030

The ADEME-Arcep study also lays out alternative scenarios to the business-as-usual scenario, pertaining to 2030 in particular. These scenarios serve to measure the decrease in the digital environmental footprint that could come about in the coming years thanks to increased efforts to improve how devices are designed and our consumption habits.

Without betting on disruptive technological innovations, they identify levers for actions involving every stakeholder (device manufacturers, network and data centre operators, users, etc.). This work resulted in three different scenarios: a “moderate sustainable design” scenario, a “widespread sustainable design ” scenario and a “digital sobriety” scenario.

3.1 What are the differences between the scenarios for 2030?

These scenarios are based on the possible progression of four variables: the volume of data traffic, the number of devices, the devices' lifespan and the digital sector's electricity consumption.

The main hypotheses that differentiate the scenarios are:

- Prolonging the life of devices by one or two years thanks to sustainable design, repair and greater digital sobriety;
- Limiting the number of devices in circulation thanks to greater digital sobriety, the use of refurbished products and device sharing;
- The gradual replacement of the most resource-hungry devices, notably by reducing the number of televisions and opting instead for projectors.

The study also delivers a reminder that replacing resource-hungry devices can also be achieved by reducing the size of TV and computer displays, which has a direct correlation with their energy consumption.

What is meant by sustainable design? What purpose does it serve?

The sustainable design of digital services means systematically incorporating environmental considerations in the design and development of products (goods and services, systems), the goal being to reduce environmental impacts across the products' life cycle, while rendering an equal or superior service. Applying this sustainable design strategy requires a rethink of how we produce our goods and services, while always keeping the minimisation of their environmental impacts in mind. Some prime examples include:

- Extending the life of devices by improving their design, their repairability, their systematic end-of-life recycling, and adapting their features to users' actual needs;
- Optimising video streams, and systematically adapting them to the different playback devices;
- Improving network hardware's energy performance and data centres' architecture;
- Optimising website and digital services' coding and data traffic management, to limit energy impacts;
- Automatic handover from a mobile to a fixed (Wi-Fi) network whenever possible.

3.2 What results could these levers for action produce by 2030?

Four forward-looking digital environmental footprint scenarios: potential progress

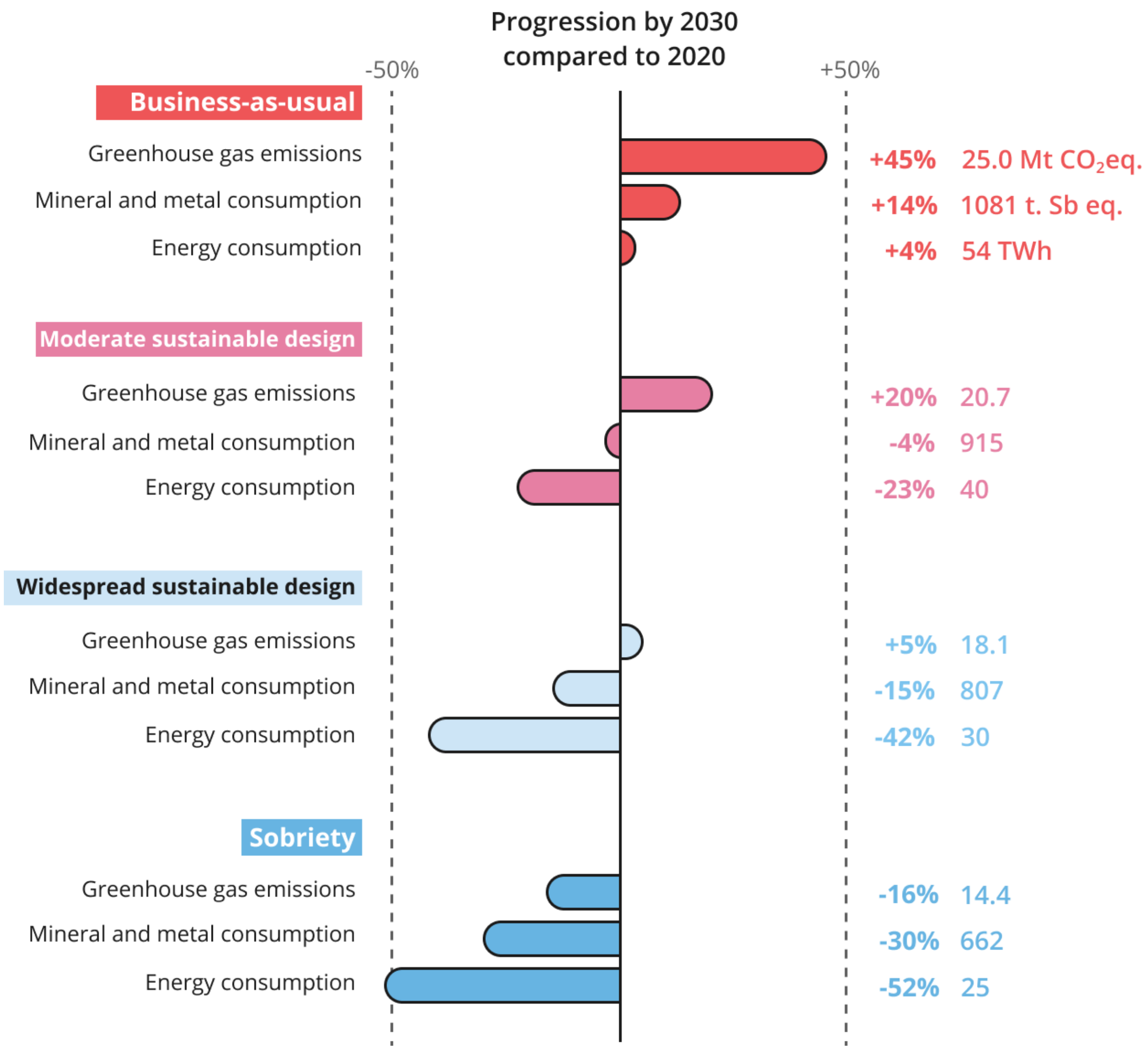
	Business-as-usual	Moderate sustainable design	Widespread sustainable design	Sobriety
Sustainable design of devices	✗	✓	✓	✓
Life of devices extended	✗	+1 year	+2 years	+2 years
TVs gradually replaced by projectors	✗	✗	✗	✓
Number of cell towers (compared to 2020)	↗	↗	↗	=
Number of devices (compared to 2020)	↗	↗	↗	=
Change in behaviours	↗	↗	↗	↗ Choice of tech most suited to purpose
Devices' electricity unit consumption	↘	↘	↘↘	↘↘
Carbon footprint (Mt CO2 eq.)	25.0	20.7	18.1	14.4
Footprint's progression compared to 2020	↗ +45%	↗ +20%	↗ +5%	↘ -16%

A combination of sobriety measures and sustainable design would help reduce the digital environmental footprint

Progression of the three main criteria (over the life cycle) under the four digital environmental footprint scenarios, compared to 2020

Digital environmental footprint in 2020

Greenhouse gas emissions: 17.2 Mt CO2 eq.
Energy consumption: 52 TWh
Metal/mineral consumption: 952 tonnes Sb eq.



These forward-looking analyses highlight the fact that applying **“moderate” sustainable design principles** would reduce digital’s energy consumption by a quarter. It would nevertheless leave our greenhouse gas emissions to increase substantially (+20%).

Going one step further by applying **"widespread" sustainable design principles** would decrease resource consumption by 15% and stabilise digital's growing carbon footprint (+5%).

Meanwhile, the combination of **digital sobriety actions** (as laid out in the digital sobriety scenario) and "widespread" sustainable design efforts would reduce greenhouse gas emissions (-16%) rather than stabilising them.

Under the **digital sobriety scenario** (which is the most ambitious in terms of reducing the digital environmental footprint), the consumption of metals and minerals that are indispensable to producing our digital devices also decreases significantly (-30%) and final energy consumption is cut in half (-52%).

Under this scenario, the number of devices in circulation levels off at around 2020 levels, whereas it increases by 65% under the business-as-usual scenario. Users, for instance, replace their old devices with more energy-efficient ones, keep them longer and adopt more sober video viewing and digital device consumption habits.

4 Up to 2050: widely disparate impacts depending on the scenario

Looking ahead to 2030, the aim of scenarios was to create a short-term forecast that combines those scenarios' various sustainable design and digital sobriety measures, and thereby identify relevant levers for action and their possible combinations. The forward-looking exercise for 2050 had a different goal.

Faced with the climate crisis, in its multi-sector study, "Transition(s) 2050", ADEME sought to open a debate on four coherent and disparate paths that could lead France to carbon neutrality in 2050.

The four forward-looking scenarios up to 2050 – namely "Frugal Generation", "Territorial cooperation", "Green technologies" and "Self-correction wager" – are each based on clear societal choices in which the role of digital technologies, their use and their impact vary. In this third volume of the ADEME-Arcep study, the authors have used these scenarios to deliver an ICT-specific investigation.

The "Frugal Generation" and "Territorial cooperation" scenarios subject the digital sector, like the rest of the economy, to strict digital sobriety measures. The "Green technologies" and "Self-correction wager" scenarios apply a hypothesis of more or less significant growth for digital, and count on new technologies having indirect positive effects on other sectors of activity, to offset its own rising emissions (e.g. Smart Buildings which, thanks to connected objects, promise to optimise heating, ventilation and air conditioning systems' energy consumption).

These scenarios established by ADEME in its "Transition(s) 2050" study are constructed with a view to achieving carbon neutrality in 2050 across the entire French economy (and not just in the digital sector). As a result, digital's greenhouse gas emissions vary from scenario to scenario but, in most of them, increase significantly.

Digital's emissions are instead offset, for instance, by the efficiency gains enabled in other economic sectors, in some cases by betting on certain technological developments. By the same token, some scenarios can generate a deferred impact, offsetting increased physical resource consumption with a reduction in greenhouse gas emissions.

It should be noted that there is a strong degree of uncertainty over the data projections. This is an inherent part of any forward-looking analysis, particularly for so fast-evolving a sector as digital, and for so distant a target timeline as 2050. The report details the methodological limitations due uncertainties over the number of devices, their features, impacts, lifespan and energy consumption.

This exercise is thus by nature imperfect, but nevertheless underscores the challenges that digital sector stakeholders will need to meet to make a positive contribution to curbing our society's environmental footprint.

4.1 Four alternative scenarios for digital up to 2050, established by ADEME

Each scenario is based on a different hypothesis, but consistent with a societal choice. A detailed account of each of the chosen hypotheses can be found in the report.

4.1.1 "Frugal Generation" scenario

- ADEME's summary description of the scenario in its "Transition(s) 2050" study: *"Major transformations in the way humans travel, heat their buildings, eat, shop and use devices, creating the ability to achieve carbon neutrality without involving carbon capture and storage technologies, which are unproven and uncertain on a large scale. The transition is achieved primarily thanks to a frugality born of restrictions and sobriety."*

its specific application to the digital sector, the **"Frugal Generation" scenario** is based on dramatic behavioural changes compared to the behaviour that has taken hold since the digital society began to flourish. This shift towards more digital sobriety could be triggered by regulatory guidelines and widespread increased awareness. It could also be imposed following shortages of raw materials, and particularly strategic materials, and crucial to the green transition (ICT is a heavy consumer of materials and competing with other sectors for them). Under these circumstances, digital entertainment is restricted to greater digital sobriety (e.g. much less mobile use), but the whole of society has access to priority digital services that are considered useful, such as health, education, mobility and culture, and to a fixed fibre network.

4.1.2 "Territorial cooperation" scenario

- ADEME's summary description of the scenario in its "Transition(s) 2050" study: *"Society transforms itself by engaging in shared governance and territorial cooperation. Non-governmental organisations, public institutions, the private sector and civil society find pragmatic ways to cooperate that make it possible to maintain social cohesion. To achieve carbon neutrality, society counts on the economic system's gradual but steady progress towards a sustainable path that combines sobriety and efficiency. Goods consumption becomes measured and responsible, and sharing mechanisms are ubiquitous."*

In its specific application to the digital sector, the **"Territorial cooperation" scenario** espouses the principles of digital sobriety and moderate sustainable design, but also seeks to freeze known digital service consumption habits in 2020 by finding practical ways to maintain them. There is a major push towards decentralisation and building an efficient territorial mesh of data servers. Material needs are systematically analysed to determine the most efficient responses possible in terms of performance and energy use. Similarly, connected object use is primarily with a view to generating energy savings.

4.1.3 "Green technologies" scenario

- ADEME's summary description of the scenario in its "Transition(s) 2050" study: *"This is the technological development that creates the ability to meet environmental challenges rather than shift behaviours towards greater digital sobriety. Metropolitan areas develop and the technologies and digital solutions, which enable energy and resource efficiency, are in every sector."*

In its specific application to the digital sector, the **"Green technologies" scenario** seeks to respond to environmental challenges more through technological development and less through digital sobriety actions. Data traffic is high and artificial intelligence is deployed in every area. Although the search for quality and performance limits excess device ownership, the number of connected objects increases sharply (as much to meet home automation needs as collective and industrial needs), as does the number of digital devices as a whole. This development path for digital seeks primarily to solve urban issues. If it supports the growth of digital rather than seeking to impede it, it also accentuates the divide with rural areas that benefit little or not at all from these innovations due to their very purpose (using AI to optimise city and public transport network management) and suffer slower speeds on mobile networks (5G and subsequent generations).

4.1.4 "Self-correction wager" scenario

- ADEME's summary description of the scenario in its "Transition(s) 2050" study: *"The ways of life of the early 21st century are maintained. But the proliferation of goods consumes a great deal of energy and materials, with potentially strong impacts on the environment. Society places its trust in the capacity to manage, if not correct, social and ecological systems thanks to more material and financial resources to sustain a habitable world. This exclusive reliance on technologies constitutes a wager as some of them are not yet mature."*

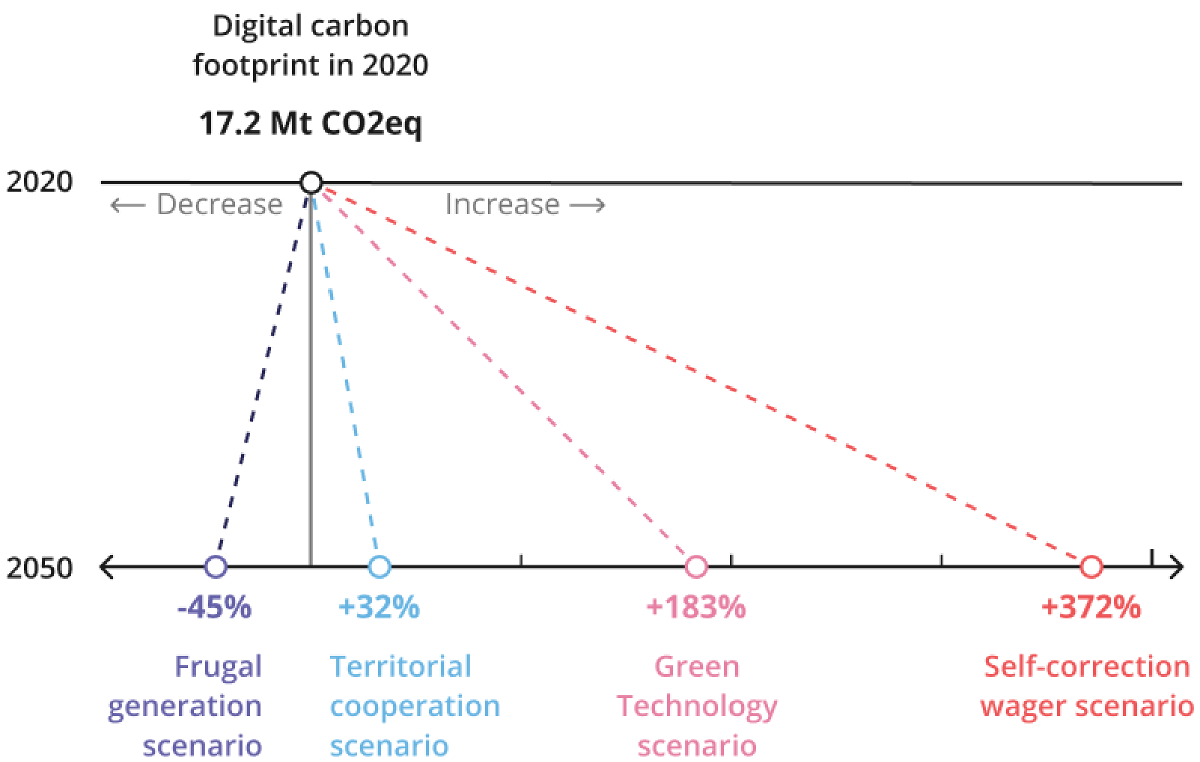
In its specific application to the digital sector, the **"Self-correction wager" scenario** sketches out the headlong rush of digital technology, whose emissions need to be offset by technological innovations like carbon capture and storage. It becomes the central link for other parts of society by guaranteeing better management and by digitalising everything that can be. This is the digital revolution at its apex. Home automation applications are found in virtually every household, entertainment and personal interactions are virtualised in the extreme. Cities have all become smart cities, powered by smart grids. The development of these services results in a massive surge in data traffic and in the number of devices in use, as much for households as businesses and public services. This system requires very frequent software updates which induces a high rate of device replacement. The digital sector's footprint soars as a result. In addition, its heavy need for the supply of materials competes with that of other economic sectors that are vital to the green transition, and raises the issue of the rarefication, if not depletion, of raw materials.

4.2 The carbon footprint in 2050 varies dramatically depending on the chosen scenario: from being cut in half to increasing by close to fivefold

Under the "Self-correction wager" scenario, the digital carbon footprint increases by 372% (double the business-as-usual scenario up to 2050). Natural resource consumption also increases to meet demand for new devices such a virtual reality headsets, and for a large number of connected objects. The number of digital devices grows 14 times compared to 2020, and the number of connected objects in particular by 43 times.

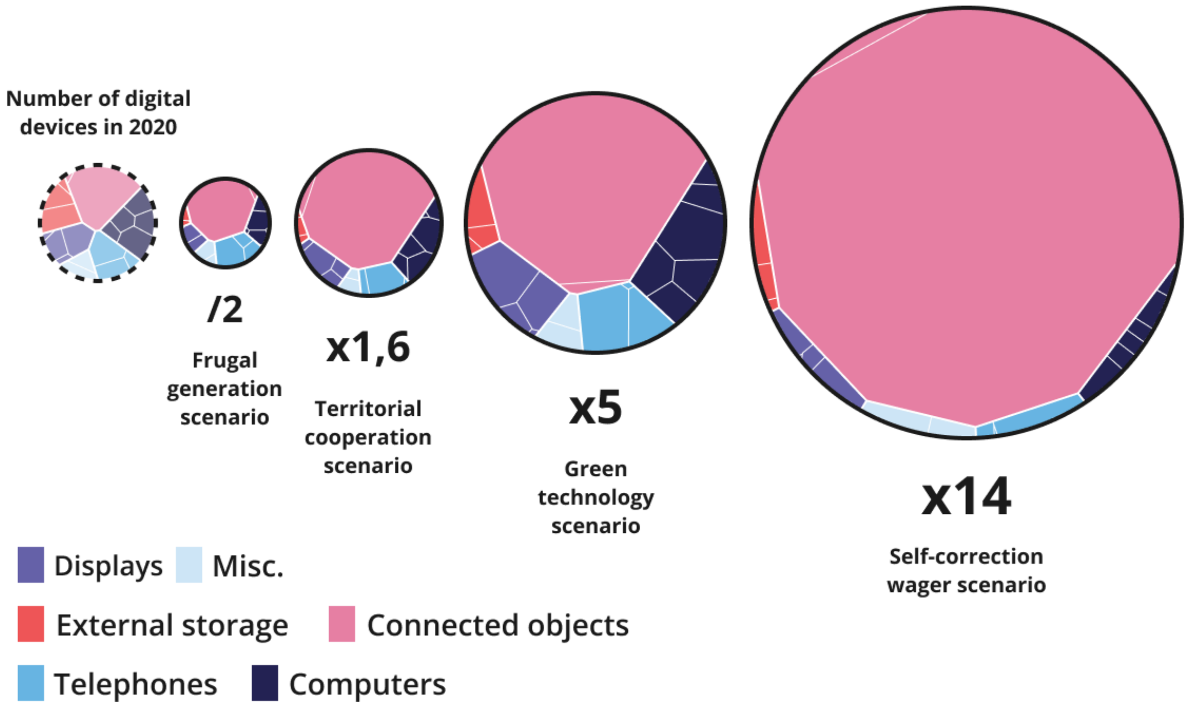
A societal choice: a carbon footprint that is quintupled or cut in half by 2050?

ADEME-Arcep study's four forward-looking scenarios for the rate of progression of ICT's CO2eq emissions up to 2050 (over the lifecycle) compared to 2020



11 billion digital devices in 2050, and almost as many connected objects?

Progression of the number of end-user devices in France in 2050 under each scenario, compared to 2020

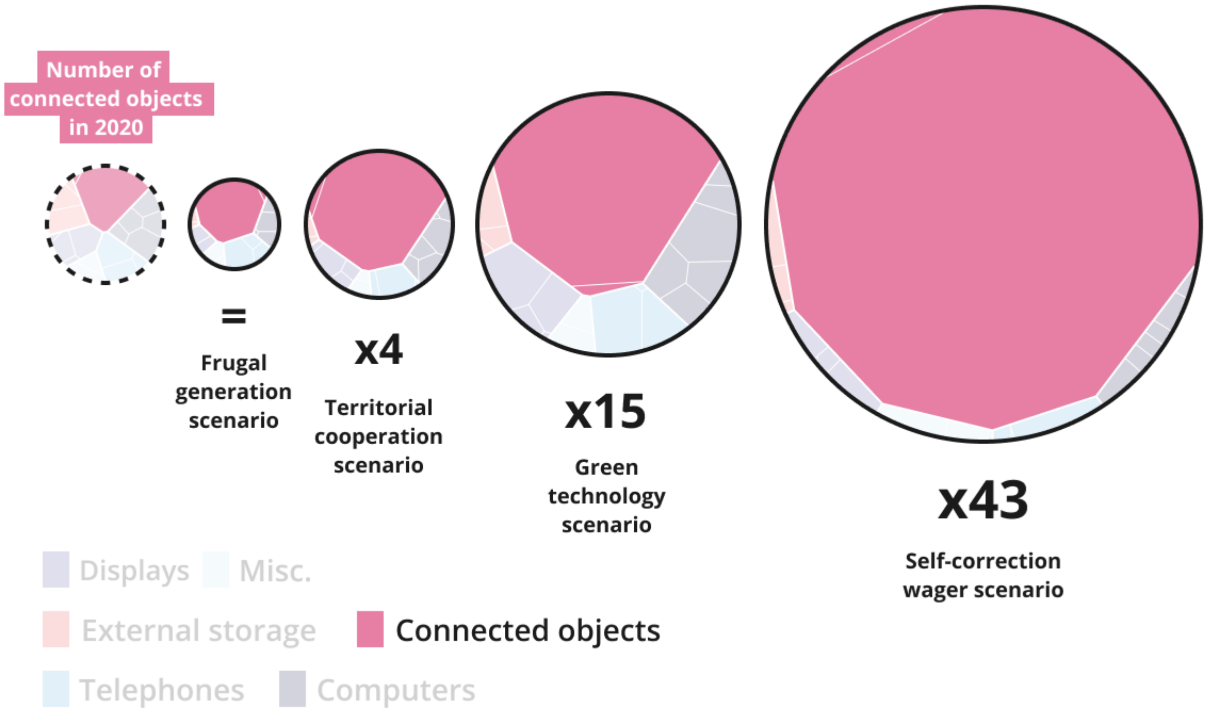


Only the “Frugal Generation” scenario results in a decrease of the digital environmental footprint, in particular thanks to connected objects levelling off at their 2020 numbers, and the total or partial replacement of the most resource-hungry devices by other types of hardware. For instance, feature phones once again account for 20% of the telephone market, at the expense of smartphones which nevertheless remain popular. Projectors, which consume fewer resources, are widely used and now on an equal footing with televisions, which most people and businesses no longer use. For the same reasons, laptop computers have replaced desktop models, and are typically shared by members of the same household, lowering their numbers compared to 2020. Video billboards have disappeared.

The “Territorial cooperation” scenario creates the ability to control the growth of digital’s footprint by keeping levels at around those of 2020, while having the entire population equipped with a smartphone and ensuring a moderate growth rate for connected objects.

Strong increase in connected objects in three out of four scenarios

Progression of the number of connected objects in France in 2050 under each forward-looking scenario, compared to 2020



Conclusion

The findings of the ADEME-Arcep study call our attention to the trajectory that digital could take if nothing is done to correct it. The scenarios crafted by ADEME, all of which have carbon neutrality as their target, involve major changes in our societies, particularly in the areas of research and development, in products and services, some of which do not yet exist, in consumption habits, production modes and the adoption of best practices by users, but also by device manufacturers, and network and data centre operators.

Analysing the business-as-usual scenarios up to 2030 and 2050 reveals that the digital sector would not commit to a path of decarbonisation and reducing its environmental impacts, contrary to the commitments made by France. While France set itself the goal of reducing GHG emissions drastically by 2050, at its current pace the digital carbon footprint will triple by 2050, and so shift the burden of compensation over to other sectors, or to the capacities of carbon sinks.

The study highlights the fact that, in addition to the **carbon footprint,** one of the major environmental issues for digital technologies is the **availability of strategic metals and the other resources used to manufacture devices** — chiefly televisions, computers, ISP routers and smartphones up to 2030, as well as connected objects up to 2050, particularly due to the implementation of new mobile network technologies.

It emerges from the study that the first lever for action is the adoption of a digital sobriety policy, which begins with an examination of the scale of development of new digital products and services, and a reduction or levelling off of the number of devices in circulation. Extending the life of digital devices, thanks to the release of sustainably designed hardware, by further developing device refurbishment and repair, and by raising consumer awareness of these issues to achieve greater digital sobriety is one key area of focus.

By the same token, to improve energy efficiency in particular, sustainable design must become systematic: for devices, but also for all ICT equipment (network infrastructure and data centres), and in network and digital service deployment procedures.

To achieve the goals of the Paris Agreement 2050, ICT must be accountable for their own impact – which is why a collective effort involving every stakeholder is so crucial.